throughout thoroughly impartial and judicial, and shows a healthy scepticism as regards theories unsupported by adequate fact. There can be no doubt that a translation into English of this admirable book would be of great assistance to all those students of bacteriology who are unable to read it in the original.

Lehrbuch der Entwicklungsgeschichte des Menschen. Von Dr. J. Kollmann, o.ö. Professor der Anatomie in Basel. Pp. xii + 658. (Jena: Gustav Fischer, 1898.)

THIS work appears to approach in method the ideal of an elementary text-book of science, since it gives a sound and well-balanced *résumé* of its subject to date, with references to authorities sufficient to place the student in direct touch with original description of detail. The pages of the book never pall, and in treatment and mode of expression it is one of the least "German" of German text-books with which we are familiar. It is illustrated by 386 excellent processed drawings, many of which are coloured, and where original these are very good and such as are likely to become popular. The investigations of His, of course, come in for a full share of recognition, and good use has been made of those of Keibel, Mall, Röse, Toldt, and others among recent workers. The book is divided into five leading sections. An introduction of sixteen pages is followed by portions dealing with the earlier stages of development ("Progenie" and "Blastogenie"), treated as far as is necessary comparatively. The fœtal membranes and progressive development of the human fœtus next come in for consideration; but the bulk of the work (405 pages) is of necessity devoted to a description of the development of systems and organs, and there is appended a twenty-page dissertation on heredity. Not the least pleasing feature of the book is its consummately artistic plan. Illustrations never obtrude themselves upon the margin nor overpower the text. In the placing of the figures, choice of their colour and descriptive letterpress, there are evidences of the bestowal of great care and forethought and of painstaking consideration of detail, which are alone a strong recommendation of the work. It is carefully written and non-pedantic, and should be deservedly popular.

Missouri Botanical Garden. Ninth Annual Report. Pp. 160. (St. Louis, Missouri: published by the Board of Trustees, 1898.)

ADMINISTRATIVE details occupy but a small part of this report, the chief contents being a collection of scientific papers and notes on interesting plants, illustrated by several half-tone plates. The results of the studies of the American Lemnaceæ occurring north of Mexico, by various botanists, are brought together by Mr. C. H. Thompson, and are combined with his own researches into a revision of the order. Mr. H. C. Irish contributes to the report a revision of the genus Capsicum, with especial reference to garden varieties. Mr. J. N. Rose describes five species of agaves which flowered in the Washington Botanic Garden in 1897, and were identified by him. One of these (*A. Washingtonensis*) appears to have been hitherto undescribed. Among the notes, Mr. William Trelease, the Director of the Gardens, records some interesting observations on Yuccas. He points out that *Yucca gigantea* is distinct from *Y. gloriosa* and *Y. Guatemalensis*—its nearest allies—and gives a figure of an Azorean specimen which is a good example of the species. With reference to the extent of the pollination of Yuccas by the Yucca moth, Mr. Trelease has now obtained information which proves the moth to be "the active agent in the pollination of Yuccas from Florida northward as far as fruit is set as a result of *Pronuba* activity, westward as far as southern California, and into the mountains of northern Mexico to the south."

LETTERS TO THE EDITOR

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Liquefaction of Hydrogen.

YOUR last issue contains a report of Prof. Dewar's remarkable achievement in the liquefaction of hydrogen and helium. In his account of it, which you quote, Prof. Dewar describes the apparatus employed as an enlarged plant of the same type as that used in his hydrogen-jet experiments discussed in his paper before the Chemical Society of December 19, 1895 (see *Proceedings*, No. 158), and in his lecture at the Royal Institution (see *Proceedings*, 1896), and illustrated in a figure printed with this lecture. An examination of that illustrative figure and of the description shows that the type of apparatus used involves an entirely new departure as compared with the methods of all who had liquefied air before 1895, including Prof. Dewar himself. The new self-intensive method then and now employed is a combination of the following four points: *a long tube conveying compressed gas, expansion of the compressed gas through a nozzle or throttle-valve, direct return of all the expanded gas over the tube of compressed gas, good interchange of temperatures between the compressed and expanded gas.* The new method embodying the above combination will be found fully described and illustrated in my patent, No. 10,165, 1895 (May 23). What is equally important historically: in November 1894, more than twelve months before Prof. Dewar first showed this new method in action, liquefying air, I had called, with an introduction, on his chief assistant, Mr. R. N. Lennox, at the Royal Institution, had there explained to him this self-intensive method, and had proposed it as a means of obtaining intensely low temperatures. By employing this method I was afterwards the first in this country to liquefy air and oxygen without employing other refrigerants. Since then, at the Royal Institution, where alone sufficient means are available for the prosecution of these researches, the same method has bridged over the space, impassable by former methods, between the temperature of liquid air and that of liquid hydrogen and helium, thus proving itself a new and valuable scientific instrument.

Under these circumstances I think that Prof. Dewar, seeing he was aware of the facts at the time of his account, ought not to have been content with eulogising the services of his assistant Mr. Lennox, but should also have given me credit for the invention of the method which has procured him so great a success. Although he has been easily able to find in old patents the separate elements which go to make up the new method—this can be done for any new invention—he has nowhere found, before the date of my communication to Mr. Lennox, that combination of the four points given above which is absolutely necessary to his apparatus for liquefying hydrogen.

The facts referred to above are stated and discussed in greater detail in a paper, to be printed shortly, which was read by me before the Society of Chemical Industry at Burlington House on the 2nd inst., with illustrative diagrams, and in letters by me to *Engineering* for April 15 and May 6.

W. HAMPSON.

Concerning the Thermodynamic Correction for an Air-Thermometer.

IT is common in works on thermodynamics to give a formula for the thermodynamic correction applicable to an air-thermometer; the following is substantially the usual proof.

Accepting the current theory of the Joule-Thomson experiments, we may show that

$$t\frac{dv}{dt} - v = k\frac{\delta t}{\delta p},$$

where k is the specific heat at constant pressure measured dynamically. From this we obtain

$$t\frac{dv}{dt} = v + k\frac{\delta t}{\delta p}$$

and

$$t = \left(v + k\frac{\delta t}{\delta p}\right) \div \frac{dv}{dt}.$$

Thus t is seen to consist of two terms; the second term

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$k\frac{\delta t}{\delta p} \div \frac{dv}{dt}$ is the smaller of the two, and we proceed to find its value. We have as a first approximation to the behaviour of gases,

$$pv = C(1 + \alpha T),$$

where T is the temperature centigrade on a gas-thermometer.

We therefore have, as approximate equations,

$$v = \frac{C}{p}\left(1 \div \alpha T\right),$$

$$\frac{dv}{dT} = \frac{C\alpha}{p}.$$

We may further assume that $\frac{dv}{dt} = \frac{dv}{dT}$, since the degrees are practically equal on the two scales.

We therefore obtain, approximately,

$$v = \frac{C}{p}\left(1 + \alpha T\right),$$

$$\frac{dv}{dt} = \frac{C\alpha}{p}.$$

Using these approximate values, we have

$$k\frac{\delta t}{\delta p} \div \frac{dv}{dt} = \frac{kp}{C\alpha}\frac{\delta t}{\delta p}$$

$$= \frac{k}{C\alpha}\frac{\delta t}{\delta \log p},$$

and the equation for t becomes

$$t = v \div \frac{dv}{dt} + \frac{k}{C\alpha}\frac{\delta t}{\delta \log p}.$$

If now, further, we use the approximate values of v and $\frac{dv}{dt}$ in the term $v \div \frac{dv}{dt}$, we shall obtain

$$t = \frac{1}{\alpha} \div T + \frac{k}{C\alpha}\frac{\delta t}{\delta \log p}.$$

This is the formula usually given.

This method of working appears to me to be incorrect, for the following reason:—

In the equation

$$t = \left(v + k\frac{\delta t}{\delta p}\right) \div \frac{dv}{dt}$$

there are two terms on the right-hand side, one of which, $k\frac{\delta t}{\delta p} \div \frac{dv}{dt}$, is small compared with the other. We may therefore neglect it as a first approximation, and we then obtain $\frac{v}{t}$ = function of p, in accordance with the laws of a perfect gas. If we wish to proceed to a closer approximation, we may use the perfect-gas laws as sufficiently good in the term $k\frac{\delta t}{\delta p} \div \frac{dv}{dt}$, because that is a small term, and the departure of the actual gas from the perfect gaseous laws will consequently in this term introduce only errors which depend on the squares of small quantities. But we are not at liberty to use the perfect gas laws in the remaining term $v \div \frac{dv}{dt}$, because it is *not* a small quantity, and we have therefore no guarantee that the use of such an approximation will not introduce errors of the first order of small quantities—that is to say, comparable with the term $k\frac{\delta t}{\delta p} \div \frac{dv}{dt}$ itself. With such errors introduced, the second approximation would not necessarily be better than the first.

The mistake in principle, which I have indicated, appears to be widespread, since it has crept into several of our well-known text-books. Thus the discussions given in Tait's "Heat" (pp. 338–339), in Baynes' "Thermodynamics" (pp. 126–127), and in Maxwell's "Heat" (pp. 211–214), all appear to me infected by this source of error. It is true that in these discussions the mistake is introduced more subtly, and is covered with a mass of symbols; whereas in the faulty investigation given above, I have purposely made the paralogism as glaring as possible. But *in substance* the mistake occurs in each of the discussions above named. JOHN ROSE-INNES.

May 13.

Printer's Ink and Photographic Plates.

IN a paper on the action exerted by certain metals and other substances on a photographic plate, by Dr. W. J. Russell (*Proc. R.S.*, vol. lxi. p. 424), the author mentions that the *Westminster Gazette* is printed with an ink which readily acts on a photographic plate. The printed paper in some experiments is placed in contact with the photographic plate, in the dark, and after being left in contact for some time, in the dark, the plate is developed, and the printed letters come out clearly. Dr. Russell mentions the names of several periodicals the print of which acts on a sensitive plate. To these the following example of the same phenomenon may be added: a photographic plate wrapped up in an advertisement sheet of *Modern Society* on development showed the printed characters very clearly, the words reading from left to right, not being reversed, so that the action must have taken place through the thickness of the paper. This sample of the action of printer's ink on a photographic plate (the property of Mr. W. B. Croft) has been in the excellent physical laboratory museum at Winchester since 1892. The print is good and clear, and probably one of the earliest observed instances of the action of printer's ink on a photographic plate in the dark, in which the physical conditions were known and recorded. F. J. JERVIS-SMITH.

Oxford, May 16.

Heavy Rainfalls.

I THINK it worthy of record that at a place called Nedunkeni, in the Northern Province of Ceylon, the rainfall on December 15–16, 1897 (24 hours), was 31·76 inches. The average annual rainfall of this place was 64·70, but in 1897 the amount totalled 121·85 inches.

The heaviest recorded rainfalls (as given in the "Encyclop. Britt.") are at Joyeuse, France, 31·17 inches in 22 hours; at Genoa, 30·00 inches in 26 hours; at Gibraltar, 33·00 inches in 26 hours; on the hills above Bombay, 24 inches in one night; and on the Khasia Hills, India, 30·00 inches on each of five successive days.

The rainfall in Ceylon, referred to above, is therefore notable. The greatest annual rainfall occurs, as is well known, on the Khasia Hills, with 600 inches. The wettest station in Ceylon is Padupola, in the Central Province, with 230·85 inches (mean of 26 years), the rainfall for last year being 243·07 inches. C. DRIEBERG.

School of Agriculture, Colombo, Ceylon.

Hermaphroditism in the Apodidæ.

I AM not sure but that the tone of Prof. Lankester's demand, in NATURE of May 12, that I should "at once" withdraw my "assertions," or confirm them by "some evidence," would not have justified my ignoring it altogether. For those of your readers, however, who may be interested in this subject, may I say that I *have* produced "some evidence" (*Ann. and Mag. Nat. History*, xvii., 1896, plates xi. and xii.), and no counter evidence whatever has yet been forthcoming to shake my faith in the justness of my conclusions. HENRY BERNARD.

Streatham, May 17.

MAGNETISM AND SUN-SPOTS.

WHEN Sir Edward Sabine was preparing his paper[1] "On Periodical Laws discoverable in the mean effects of the larger Magnetic Disturbances—No. ii.," in which he discussed the magnetic observations made at the temporarily established Colonial observatories at Toronto and Hobarton, he found that there existed at these places, in the years 1843 to 1848, a progressive increase in amount both of magnetic disturbance and in extent of diurnal range of the declination magnet, the values of diurnal range for the year 1843 having become in 1848 increased by some 40 per cent., the Toronto values for these years being 8′·90 and 12′·11 respectively, and the Hobarton values 7′·66 and 10′·63. This was an altogether unlooked-for result, one that engaged his special attention, such increase of value from year to year

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[1] Read before the Royal Society, May 6, 1852.

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